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955 L'ENFANT PLAZA NORTH, S.W. WASHINGTON, D. C. 20024

B70 09068

SUBJECT: Comparison of Size-Frequency Distribution of Large Craters Around the General Area of Fra Mauro and Descartes Landing Sites - Case 340

DATE: September 28, 1970

FROM: V. Hamza

ABSTRACT

The size-frequency distribution of craters from one-thousand meters to tens of meters in diameter was determined for the general area of the landing sites Fra Mauro and Descartes in order to compare one type of roughness at the two areas. The normalized size-frequency distribution of craters in the Descartes area is comparable to that of the Fra Mauro area. The effect of sun elevation on crater counting appears to be negligible if the photographs lack geometric shadows (e.g., the sun elevation angle is above 25°-30°). A fairly accurate count may be obtained under stereoscopic conditons even for photographs taken under high sun elevation angles (e.g., 70°).

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MEMORANDUM FOR FILE

I. INTRODUCTION

The purpose of this study is to determine the effect of sun elevation angle on crater counting and to establish the relative terrain roughness between the area surrounding the Fra Mauro landing site and the proposed highland landing site of Descartes.

The prime landing site for the aborted Apollo 13 mission was located at approximately 3.5°S, and 17.5°W, about 80 km north of the Fra Mauro crater. The same landing site is planned for the Apollo 14 mission in January, 1971. The Fra Mauro Formation, a lunar surface unit that radially surrounds Mare Imbrium, was originally photographed by Lunar Orbiter III for a possible Surveyor landing. It has since been photographed from the Command Module during the Apollo 12 mission.

The Descartes region is of high scientific interest because, if approved as a future Apollo landing site, it would enable sampling two wide-spread geologic units in the central highlands. The proposed landing site is located at approximately 8.5°S, and 16°E, north of the crater Descartes. The existing photography of this area is limited to pictures taken by the Lunar Orbiter IV spacecraft ($\sim$60 meter resolution, not adequate for the Apollo site selection procedures) and by the CM pilot during the Apollo 12 mission ($\sim$25 meter effective resolution).

The Apollo 12 photographs of the Fra Mauro and Descartes areas were taken with the Hasselblad 500 mm lens at the high sun elevation angles of 40° and 73° respectively. In the latter case the photographs are of an area about 8 km to the east from the originally planned site. Additionally, it has been argued that the low resolution and low contrast due to high sun angles (about 70°) make the Apollo 12 photography of Descartes inadequate for site analysis. For this reason the Descartes landing site will be photographed again on Apollo 14 with a Hycon camera ($\sim$1 meter lunar surface resolution) at a lower sun elevation angle ($\sim$32°). In the meantime, however, it is of operational interest to find out how different the proposed Descartes landing area is from the one already selected for the next mission - Fra Mauro.

II. METHOD

Initially, two Apollo 12 photographs of the Fra Mauro and Descartes landing sites were chosen and the cumulative number of craters in each area was determined. Because of the above mentioned limitations of surface resolution due to the high sun elevation, this type of analysis applies only to large craters (e.g., greater than 25 meters in diameter). Futhermore, the Apollo 12 photographs display a recognizable vignetting in all four corners. For this reason the craters were counted only in the central portion of the photographs.

The photographs selected for this analysis are AS12-53-7835, a vertical photograph of the general area of the Fra Mauro landing site at a sun elevation angle of 40° (Figure 1), and AS12-53-7796, a vertical photograph of the general area of Descartes at a sun elevation angle of about 73° (Figure 2). A crater count for each photograph was performed with the help of an overlay. Because both photographs are part of a group of stereopairs a second crater count was performed for each photograph under the stereoscope. A third Fra Mauro count was performed on a medium resolution photograph taken at relatively low sun angle ($\sim$22°) by the Lunar Orbiter III - M-133 (Figure 3). The portion of the photograph, which contains the Fra Mauro landing site, is marked by the white borderline and was enlarged to a size of 18.5"x18.5". The crater count was performed on the enlarged photograph. A third Descartes count was made on an enlarged photograph (18.5"x18.5") of an area shown in Figure 2. In order to determine the effect of sun elevation angle on crater recognition in the general area of Descartes (including the proposed landing site), a photograph (AS12-56C-8436) taken with the 80 mm lens was used for counting. The latter photograph was taken earlier in the mission under the Multispectral Photography Experiment (S-158) at approximately 59° sun angle.

III. RESULTS

The cumulative frequency of craters versus crater diameter is plotted in Figure 4 for the Fra Mauro area and in Figure 5 for the Descartes area. It appears that under stereoscopic conditions higher counts are encountered for the 250 to 700 m craters (which under monoscopic conditions are difficult to recognize because of the lack of geometric shadows). In the case of the Fra Mauro area, the stereoscopic crater count compares well with the monoscopic count of the Lunar Orbiter III M-133 enlarged photograph taken at SA=22°. In Figure 5 the crater count performed on enlarged photographs at SA=73° shows no significant change with the data obtained for SA=59°. However, it must be remembered that both sun angles are high enough to result in a lack of geometric shadow. One concludes, therefore, that once the geometric shadows disappear above approximately SA=25°-30° there is relatively little difference

in crater recognition for a comparable resolution. It seems, then, that if the photograph of an area is taken above the limiting sun elevation angle for geometric shadows the crater count is independent of sun elevation angle and a fairly accurate count may be obtained under stereoscopic conditions.

The upper bounds of crater distribution in Figures 4 and 5 are plotted in Figure 6 for comparison. If the data for craters smaller than 60 m (where surface resolution is the limiting factor) and for craters larger than 1000 m (where abundance is the limiting factor - not enough crater counted) are omitted then it is seen that the Descartes area has a maximum of about 30% more craters in the 60 m $\leq d \leq$ 400 m range than the Fra Mauro area. In the 400 m $\leq d \leq$ 1000 m range the Fra Mauro area has a maximum of about 20% more craters than the Descartes area.

IV. CONCLUSIONS

The crater count obtained from Apollo 12 photographs and a Lunar Orbiter photograph in the case of Fra Mauro shows that the size-frequency distribution of large craters (60 m $\leq d \leq$ 1000 m) in the Descartes area is comparable to that of the Fra Mauro area. It appears that if a photograph of an area is taken above the limiting sun elevation angle for geometric shadows (25° to 30°) the crater count becomes independent of sun elevation and a fairly accurate count may be obtained under stereoscopic conditions.

V. Hamza

2015-VH-kmj

Attachments
Figure 1-6

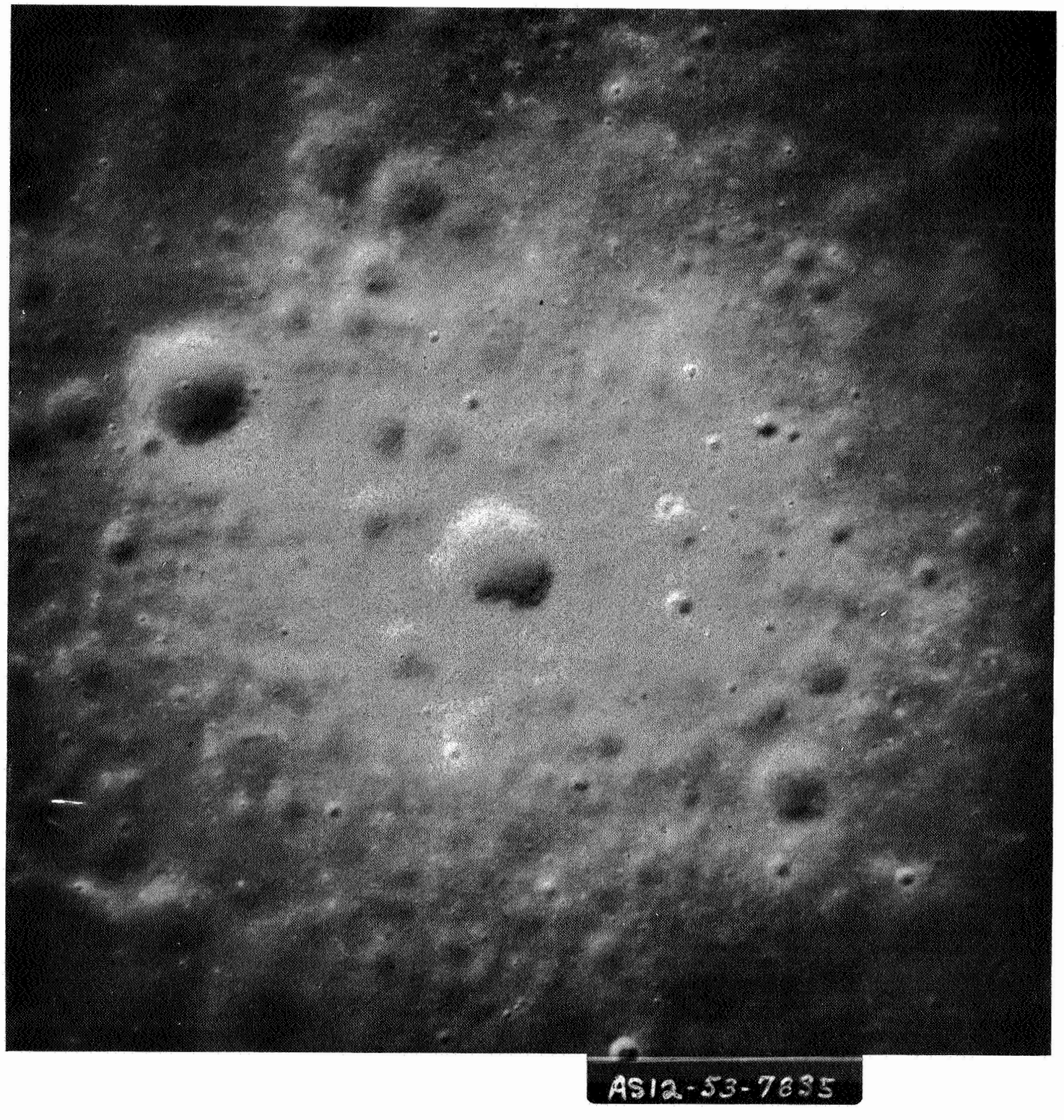

FIGURE 1 - VERTICAL PHOTOGRAPH OF FRA MAURO AREA (3.5°S, 18°W)

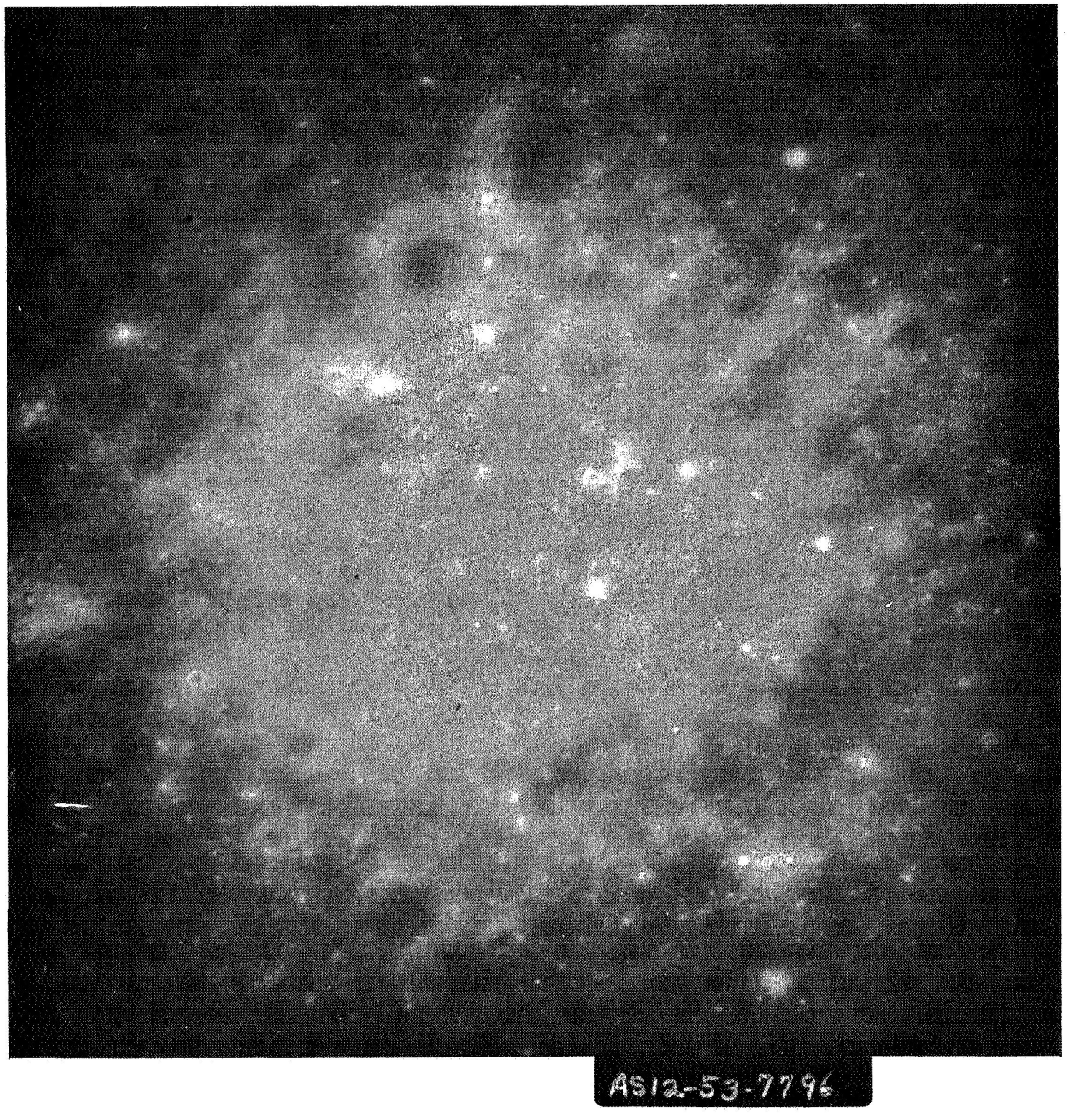

FIGURE 2 - VERTICAL PHOTOGRAPH OF DESCARTES AREA (9°S, 16°E)

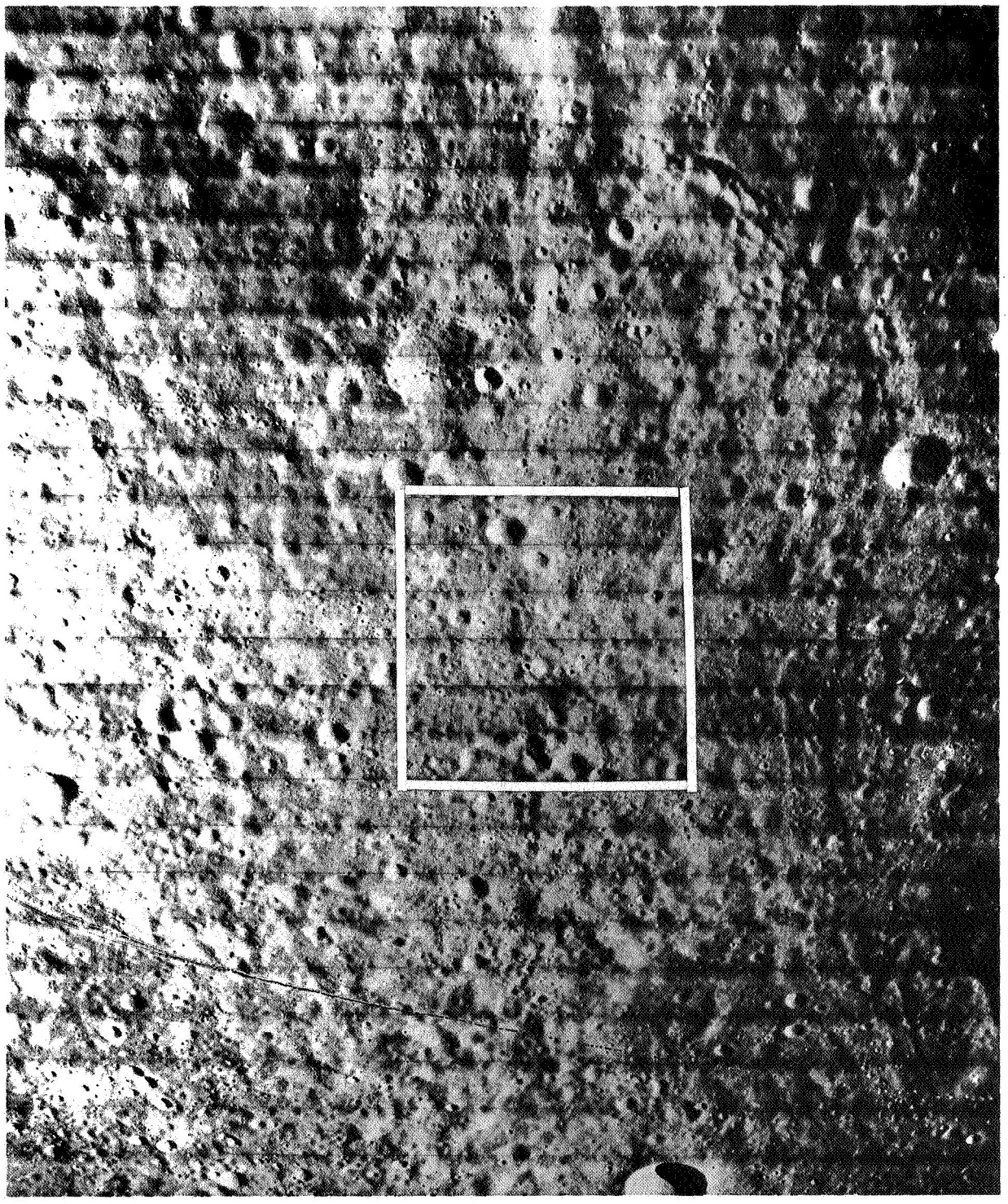

FIGURE 3- LUNAR ORBITER III PHOTOGRAPH (FRAME M-133) OF FRA MAURO AREA

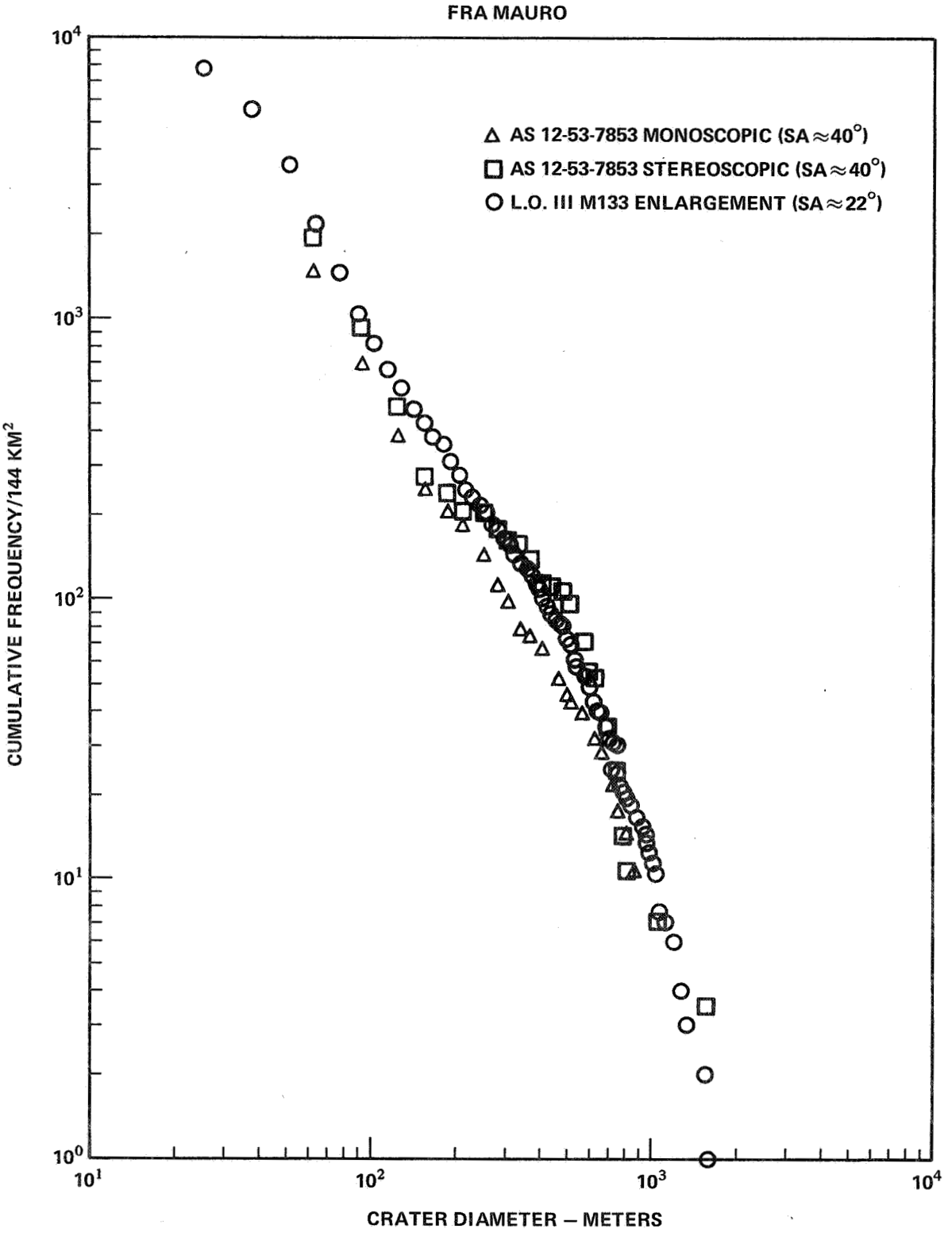

FIGURE 4 - CUMULATIVE SIZE-FREQUENCY DISTRIBUTION OF CRATERS ON THE LUNAR SURFACE IN THE FRA MAURO AREA

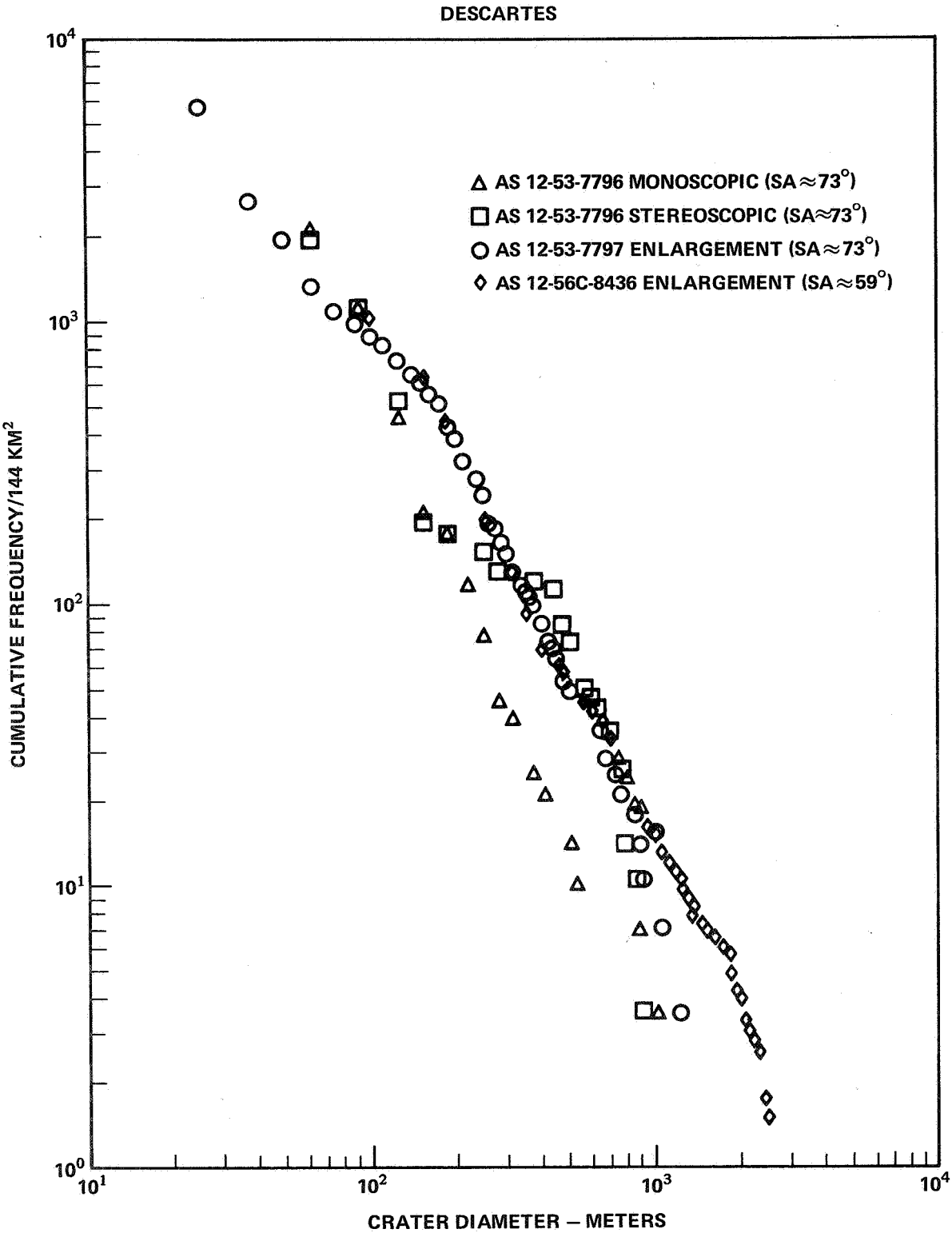

FIGURE 5 - CUMULATIVE SIZE-FREQUENCY DISTRIBUTION OF CRATERS ON THE LUNAR SURFACE IN THE DESCARTES AREA

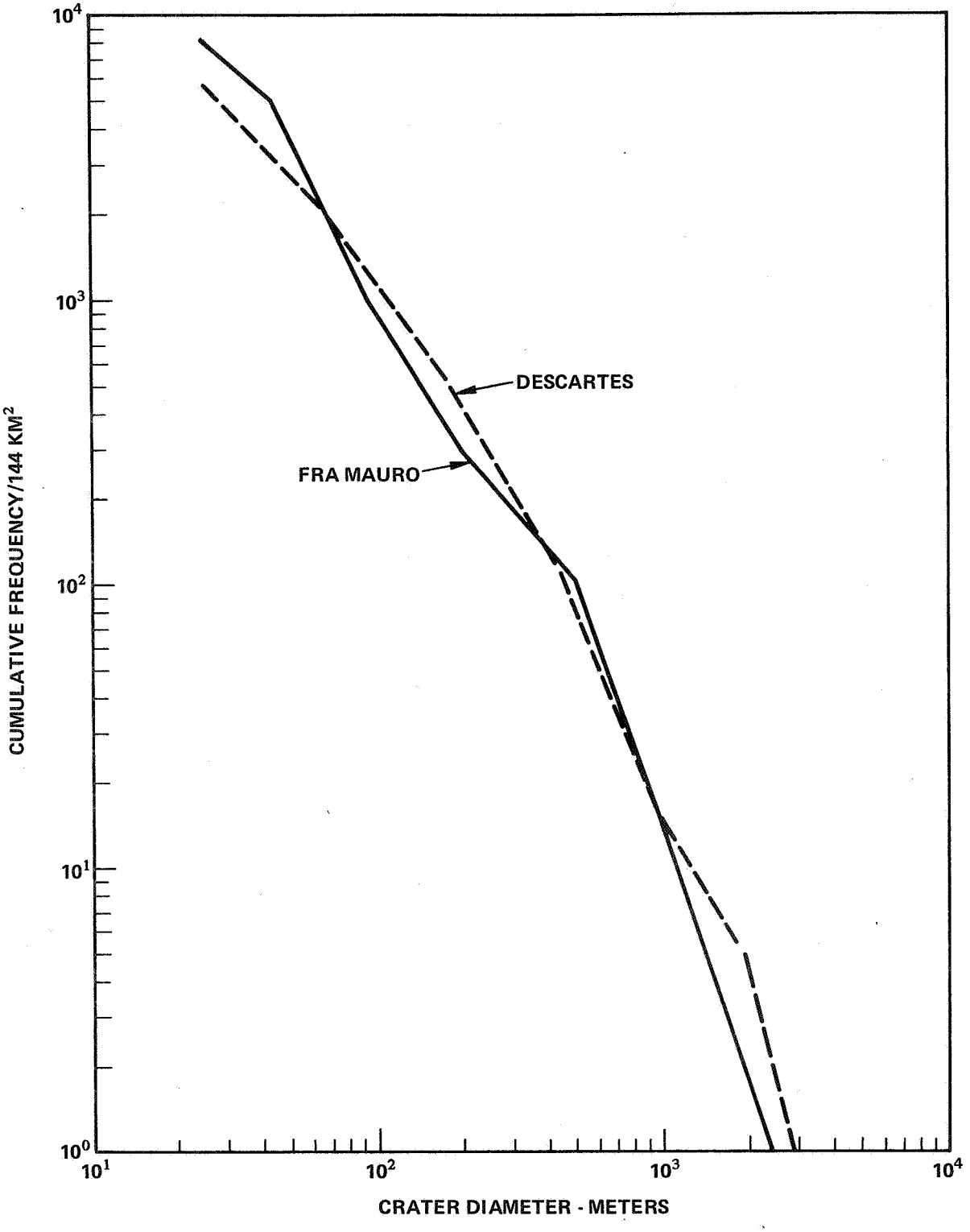

FIGURE 6 - CUMULATIVE SIZE-FREQUENCY DISTRIBUTION OF CRATERS ON THE LUNAR SURFACE IN THE FRA MAURO AND DESCARTES AREAS

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